Achievements and Opportunities of Digitalization in Productivity Management

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Abstract. Digitalization changes the handling of data and information by offering new and extended opportunities for collecting, transferring, evaluating and exploiting information. This allows increases in effectiveness and efficiency and also opens new opportunities for productivity management. To analyze how these opportunities are used in the German industry and which potential for further development is estimated, the Institute of Applied Industrial Engineering and Ergonomics conducted an online survey querying specialists and managers in the year 2019. Partial results for the German metal and electrical industry are described and discussed in this contribution. They prove the increasing use of digitalization and the related expectations within this significant industrial branch.

Keywords: Digitalization · Productivity management · Human factors

1 Opportunities of Digitalization and Relevance of Productivity

Digitalization refers to the increasing presence and use of digital technologies. It generally enhances the opportunities for handling data and information. This affects the complete handling process [1], starting with a mostly sensor-based acquisition of data, which usually works automatically and includes digitization – the building of digital representations of the acquired data. In this way, data get prepared to be transferred fast and secure via digital networks – wired or wireless. Afterwards, available data can get processed as required by using appropriate software and algorithms, which may include artificial intelligence or machine learning. Thereafter, information can be made available to employees or technical systems while considering specific needs of the actual situations or specific requirements of a specific human. Finally, employees or technical systems can use received information for a wide variety of purposes. Thus, the effectiveness and efficiency of data handling can be increased significantly.

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This leads to new and enhanced opportunities also for productivity management [2]. An increased availability of data includes historical as well as real-time data which can be analyzed and used for improving productivity. Due to that, needs for action of productivity management can get recognized and communicated faster. Consequently, adequate measures can get developed and implemented earlier. Similarly, control loops can get implemented or improved faster as well as integrated into holistic considerations of corporate issues. This facilitates the alignment of productivity management with corporate strategies. Further developments of digitalization are illustrated for example in the "German Standardization Roadmap on Industry 4.0" [3].

2 Methodology

The use of digitalization for productivity management in the German industry as well as its effects on employees were subject of a nationwide online survey conducted in the year 2019. Selected questions from previous studies from the years 2015 [4] and 2017 [5, 6] were replicated to be able to analyze development tendencies. Most of the questions were asked with pre-defined answering options, some of them could be supplemented by a free text answer. Estimations of future changes were recorded either as percentages to be entered freely or using three to four-level scales.

A total of 178 specialists and managers answered the questions in the period from May to August 2019 (16 weeks). The majority of these are from the industry (77%; especially the metal and electrical industry) and the service sector (17%). Other economic sectors are represented in the sample only marginally.

Within this contribution, only answers from the German metal and electrical industry are considered (n = 112). These participants' majority (78%) works at company locations with more than 250 employees. This also applies to the company size: 94 percent of the participants stated to work in companies with more than 250 employees. According to the EU definition [7], these are large companies. Compared to the size distribution of all companies in Germany, large companies are over-represented in the sample. The participants' majority works in production management (25%), corporate management (19%), human resources (19%) or industrial engineering (16%).

The survey results were analyzed descriptively using SPSS and Excel. A significance level of $\alpha = .05$ was chosen for correlation analyses [8]. Alternative answer options rated on Likert scales were sorted based on the summarized proportions of positive and negative answers.

3 Availability, Presentation and Use of Data for Productivity Management

As data and the contained information are the basis of digitalization, participants were queried which productivity-relevant data are available digitally, how they are presented and how they are used.

Different kind of data and their actual, planned or non-planned availability are illustrated in Fig. 1. Historical data are available in 88 percent of the companies the participants work for. To plan or not-plan realizing an availability of historical data answered 3 percent each. This item has the lowest uncertainty (6%) of all items of this question. Real time data are available for 58 percent of the respondents. Nearly a third (31%) is planning such and 4 percent do not. There is availability of data from other locations of the own company for 48 percent of the participants. Further 12 percent are planning such and 19 percent do not. The lowest agreement was given to the availability of data from other companies within the value chain (21%). Further 13 percent are planning such kind of cooperation with other companies and 39 percent do not. This item caused the highest uncertainty to the respondents (28%) within this question.

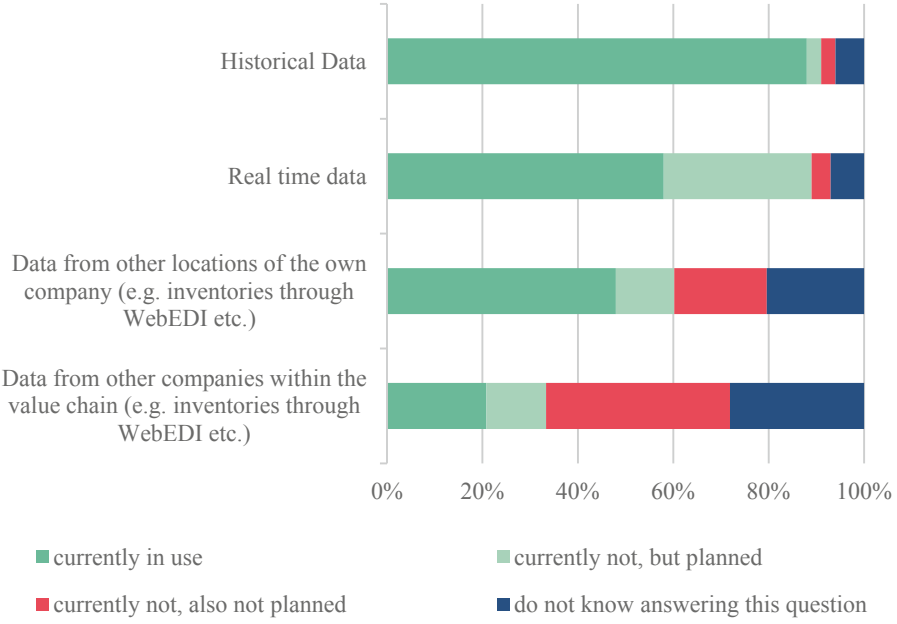

Fig. 1. Which productivity-relevant data are available to you digitally? (n = 96–100)

Compared to the results of the same question from the year 2017 [5] the availability of historical data is merely constant. The availability of other kinds of data increased a little each (1–7 percentage points). The planned availability of real time data increased strongly (12 percentage points).

Digital access to productivity-relevant data is given by different kinds of display technologies (see Fig. 2). In most companies, classical computer displays are in use (87%) or planned to be used (11%). Only 2 percent of the participants responded, such displays are not in use and will not be. Video projectors – also a more classical technology – are used a little less than classical displays: 67 percent use them and 4 percent plan to. The use or planned use of newer technologies as tablet computers

(89%) and smartphones (78%) is very common. While the aforementioned technologies are for the most part in use and only the smaller percentage of the participants indicated to use them in the future, smart glasses and watches show a contrary structure. There are more respondents planning to use them then are already using them. Compared to the results of the same question from the year 2017 [5], the use and the planned use have increased for all display technologies by 5 to 27 percentage points. Smartphones show the largest increase (from 33 to 60 percent).

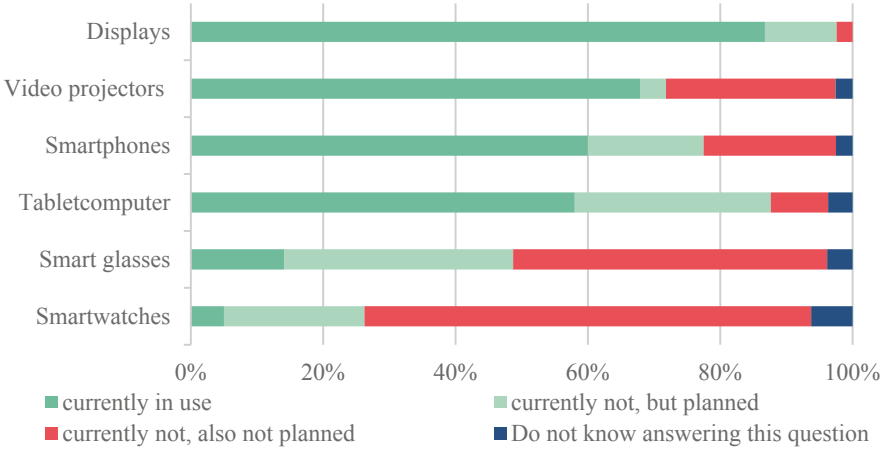

Fig. 2. Do you use the tools listed to provide productivity-relevant data? (n = 78–81)

The gained data are used for productivity management in different intensity and consequence. This heterogeneous use among the participants is illustrated in Fig. 3: Most respondents (33%) compare targeted and reached values to derive targeted actions for influencing and improving productivity. Nearly a quarter of the respondents tracks their past development (26%) or does at least the comparison (25%), while some use them only if necessary (8%), view them irregularly (5%) or use them differently (3%). Answers to the latter were: everything depending on the department, in meetings, online on the shop floor, for annual planning, in live dashboards, for monthly reports.

If data are not used for deriving targeted measures, the relevance of collecting them should be evaluated. Furthermore, their suitability for closing control loops and improving productivity should be checked [6].

4 Impact on Human Factors and Future Expectations

Independently from the way productivity management is organized in different companies, it affects human factors and expectations on future developments.

Consequently, these aspects were part of the survey. It was found that productivity management improves or improves strongly the employees' productivity in most cases (97%, see Fig. 4). Furthermore, all respondents agree on productivity management

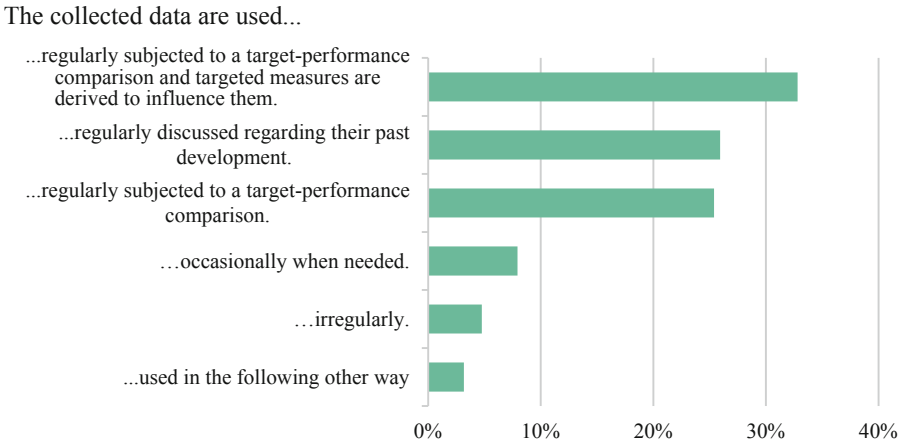

Fig. 3. How are collected data used for productivity management? (n = 91; multiple choices possible, 189 answers in total)

improving or improving strongly the ergonomic workplace design (100%). Also, the employees' ability to work (91%) as well as their qualification level (85%) and ability of autonomous decisions (68%) are improved or improved strongly by the help of productivity management. Additionally, the employee's flexibility is improved by productivity management. This applies to content flexibility (80%, range of executable tasks), temporal flexibility (75%, variation of working hours) and spatial flexibility (70%, variation of workplaces).

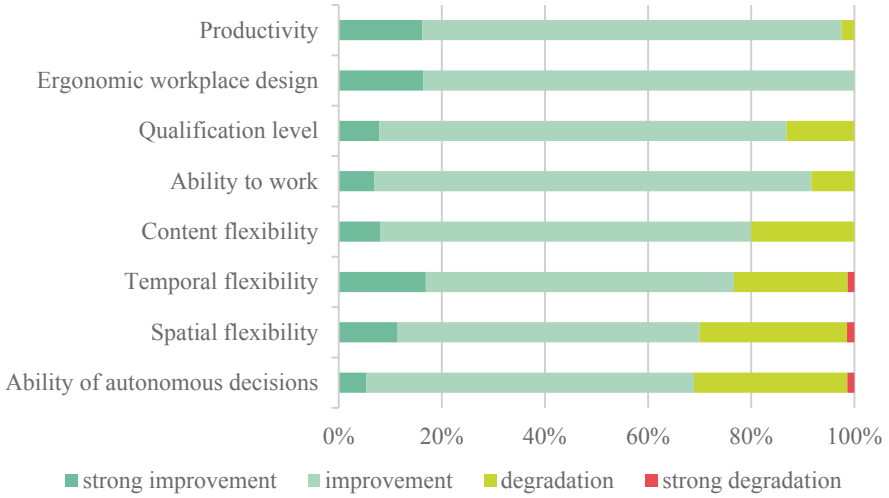

Fig. 4. How are your company's employees influenced by productivity management? (n = 100–111)

Compared to the results of the year 2017 [5], there are only little changes for most items; only the ability of autonomous decisions was estimated better by 35 percentage points in the year 2019.

Since productivity and its management are depending increasingly on digital technologies and digitalization, it was queried which increases in productivity are estimated due to this. These estimations were queried for/until the year 2022 and the year 2027. Since this question was replicated from the prior survey [5], the actual and the past results can be combined. To do so, all results are illustrated in Fig. 5. It shows a clear and steady tendency which reaches from an estimated increase of productivity of 22 percent on average in the year 2020 up to 38 percent on average in the year 2027. The deviations in the estimations increase with the forecast horizon as it can be expected.

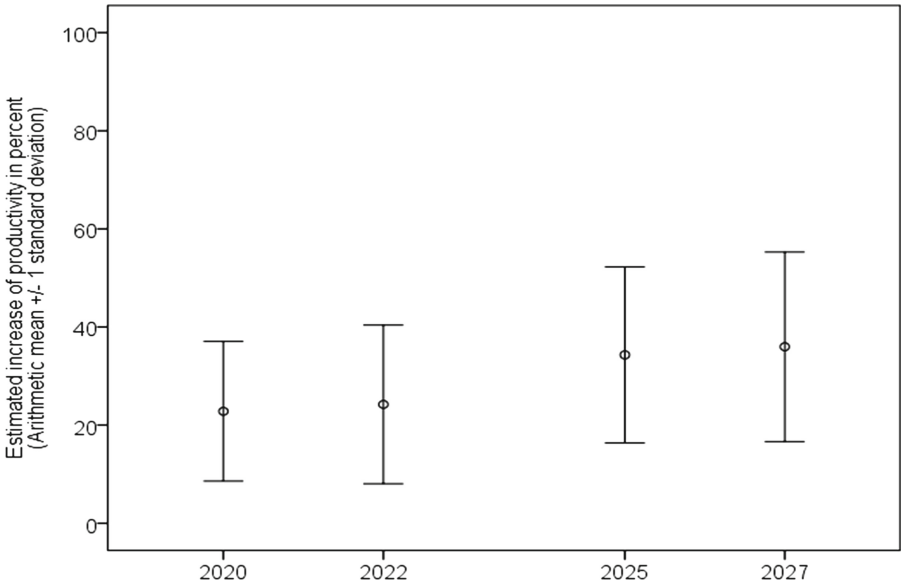

Fig. 5. How much productivity gain do you estimate due to digitalization or the introduction of digital technologies in your company? (n = 70–72 until the year 2020 respectively until 2025; n = 85–87 until the year 2022 respectively until 2027)

5 Summary and Outlook

Digitalization opens new opportunities for handling data and improving productivity thereby. For analyzing the actual use and the expectations on future potential for improving productivity, an online survey has been conducted in the German industry. Within the questionnaire, some questions were replicated from two previous studies to allow an estimation of development tendencies.

Selected results for the German metal and electrical industry are illustrated and described in this contribution. The findings show that the availability of data and information has increased between the year 2017 and the year 2019, while especially the planned availability of real time data increased significantly. The technologies for presentation of data and information are merely classical computer displays and video beamers. Within the last two years, especially the use of tablet computers and smartphones increased, while the planned use of smart watches and smart glasses increased, too. The participants' majority uses productivity-relevant data regularly to compare targeted and reached values and to derive adequate measures for influencing and improving productivity.

The answers to the impact on human factors are quite constant and show improvements in individual productivity, ergonomic workplace design, flexibility (content, temporal, spatial), ability to work and qualification level. The ability of autonomous decisions was estimated significantly better by 35 percentage points than two years before. Estimations on future potential of digitalization for productivity show a steady increasing development up to 38 percent on average until the year 2027.

Thus, the results proof the impact of digitalization on the German metal and electrical industry and its potential for improving productivity within. The complete study – containing more and more detailed analyses of all branches – is available online for free on www.arbeitswissenschaft.net/Studie_Digitalisierung_2019.

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